

# Claims

- [c1] What is claimed is:
- 1.A fuel delivery system comprising:  
a fuel pump configured to deliver fuel to an engine and  
rated to operate in an operational voltage range; and  
a fuel pump controller connected to the fuel pump and  
configured to control operation of the fuel pump to op-  
erate with a voltage input outside the operational voltage  
range of the fuel pump.
  - [c2] 2.The fuel delivery system of claim 1 wherein the opera-  
tional voltage range of the fuel pump is 10–18 volts.
  - [c3] 3.The fuel delivery system of claim 2 wherein the fuel  
pump has a rated nominal voltage of 12 volts.
  - [c4] 4.The fuel delivery system of claim 2 wherein the voltage  
input is variable between 12 volts and a rail voltage.
  - [c5] 5.The fuel delivery system of claim 4 wherein the rail  
voltage is nominally 55 volts.
  - [c6] 6.The fuel delivery system of claim 1 wherein the voltage  
input is at least 30 volts.

- [c7] 7.The fuel delivery system of claim 1 wherein the fuel pump controller includes a fuel pump drive circuit and a voltage sensing circuit, and wherein the engine is a two-cycle internal combustion engine.
- [c8] 8.The fuel delivery system of claim 7 wherein the two-cycle internal combustion engine is configured to provide thrust for a watercraft.
- [c9] 9.The fuel delivery system of claim 8 wherein the two-cycle internal combustion engine forms a portion of an outboard motor.
- [c10] 10.The fuel delivery system of claim 1 wherein the fuel pump controller is configured to energize the fuel pump during engine cranking to pressurize a fuel system.
- [c11] 11.The fuel delivery system of claim 1 wherein the fuel pump controller is configured to condition the input according to pulse width modulation.
- [c12] 12.The fuel delivery system of claim 11 wherein the fuel pump controller includes a switch designed to repeatedly switch between an ON state and an OFF state at approximately 10 kHz to control power dissipation in the fuel pump.
- [c13] 13.The fuel delivery system of claim 12 wherein the fuel

pump controller is further configured to run the fuel pump at a constant current of approximately 3 amperes.

- [c14] 14.A control unit comprising:  
a fuel pump drive circuit connected to a fuel pump rated to operate in a first range of voltages;  
a voltage sensing circuit connected a voltage rail, the voltage rail having a rail voltage outside the first range of voltages; and  
a processor connected to the voltage sensing circuit and the fuel pump drive circuit to control operation of the fuel pump to operate at the voltage rail.
- [c15] 15.The control unit of claim 14 wherein the processor is programmed to pulse width modulate the fuel pump drive circuit to control power dissipation in the fuel pump operating at the rail voltage.
- [c16] 16.The control unit of claim 15 wherein the voltage sensing circuit is configured to monitor the rail voltage and determine a duty cycle for pulse width modulation therefrom.
- [c17] 17.The control unit of claim 16 wherein the duty cycle is defined by a ratio of a maximum of the first range of voltage and monitored rail voltage.
- [c18] 18.The control unit of claim 17 wherein the maximum of

the first range of voltage is 18 volts and the monitored rail voltage is between 12 volts and 60 volts.

- [c19] 19. An outboard motor comprising:  
an internal combustion engine configured to provide thrust to propel a watercraft and having an alternator configured to produce an operating rail voltage within a rail voltage range when the internal combustion engine is running;  
a fuel pump having a rated maximum voltage that is below the rail voltage range, wherein the fuel pump is configured to supply fuel to the internal combustion engine; and  
a control unit having a control circuit to control the fuel pump to operate at a rail voltage that exceeds the rated maximum voltage.
- [c20] 20. The outboard motor of claim 19 further comprising a DC energy source connected to condition power from the alternator to provide DC power to the fuel pump at a voltage within the rail voltage range that exceeds the rated maximum voltage.
- [c21] 21. The outboard motor of claim 20 wherein the rail voltage range is from 12 volts to 60 volts.
- [c22] 22. The outboard motor of claim 20 wherein the DC en-

ergy source includes a switching regulator constructed to convert AC power generated by the alternator to DC power and input the DC power to the fuel pump at a voltage that exceeds 12 volts.

[c23] 23.The outboard motor of claim 22 wherein the switching regulator is further configured to provide DC power to the fuel pump at a voltage of 30 volts.

[c24] 24.The outboard motor of claim 19 wherein the control circuit is further configured to control the fuel pump to be operable at variable voltages.

[c25] 25.The outboard motor of claim 19 further comprising a fuel pump drive circuit connected to the fuel pump and configured to control fuel pump operation based on input received from the control unit.

[c26] 26.The outboard motor of claim 25 wherein the control circuit is further configured to pulse width modulate the fuel pump drive circuit.

[c27] 27.The outboard motor of claim 26 wherein the control circuit is further configured to pulse width modulate the fuel pump drive circuit to maintain pump operation at approximately 3 amperes.

[c28] 28.The outboard motor of claim 26 wherein the control

circuit is further configured to pulse width modulate the fuel pump drive circuit at 10 kHz.

[c29] 29.The outboard motor of claim 19 wherein the internal combustion engine is a two-cycle engine.

[c30] 30.The outboard motor of claim 19 wherein the internal combustion engine is a rope-start engine.